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Exposure to an unpredictable and competitive social environment affects behavior and health of transition dairy cows

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ABSTRACT

Social factors are important determinants of disease in humans and and laboratory animals, but less research has been done using farm animals. The objective of this study was to determine if an unpredictable and competitive social environment affects behavior and health during the transition period when dairy cows are at high risk of disease. Five weeks before calving, 64 cows were assigned to a predictable and noncompetitive social environment (predictable) or an unpredictable and competitive social environment (unpredictable) using 8 groups of 4 animals per treatment. Each group consisted of 3 multiparous and 1 primiparous cow. At first enrollment (baseline; 5 wk before calving), all groups had access to 4 electronic feed bins. At 4 wk before calving, cows in the predictable groups were given access to 6 feed bins, and cows in the unpredictable groups were moved into a new pen with 4 resident cows each trained to consume feed from one bin. Each cow in the unpredictable group was then provided access to only 1 of the 4 feed bins which they shared with 1 resident cow (resulting in 2 cows/bin), creating a competitive feeding environment. To create an unpredictable environment, access to morning feed was delayed 0, 1, 2, or 3 h every other day. On alternate days, the cows in unpredictable groups were assigned to feed from a new feed bin (and thus had to compete with a new resident partner). Feeding and social behavior were collected electronically from the feed bins. Blood was sampled at baseline (wk −5), wk −2, wk −1, and wk +1 relative to calving to measure inflammatory (haptoglobin and tumor necrosis factor-α) and metabolic (nonesterified fatty acids, β-hydroxybutyrate, calcium, and glucose) biomarkers. Uterine cytology was performed 3 to 5 wk after calving to diagnose cytological endometritis. Data were analyzed using mixed models including baseline data as a covariate, week as a repeated measure, treatment as a main effect, and a treatment by week interaction. The probability of cytological endometritis at the group level was analyzed using Mann-Whitney U tests. Parity was included in separate models to determine any parity × treatment interactions. Cows from both treatments consumed the same amount of feed, but cows in the unpredictable group spent less time feeding and had a higher rate of feed intake. Cows in the unpredictable groups also visited the feed bins less often, consumed more feed during each visit, and were involved in more social replacements at the feed bin compared with predictable groups. Cows in the unpredictable groups had higher serum concentrations of nonesterified fatty acids and tumor necrosis factor-α, but lower β-hydroxybutyrate compared with predictable groups. Multiparous cows in unpredictable groups were more likely to be diagnosed with cytological endometritis after calving compared with cows in the predictable groups, but primiparous cows in unpredictable groups showed a tendency for the opposite response. These results suggest that an unpredictable and competitive social environment before calving causes changes in feeding and social behavior, some physiological indicators of metabolism and inflammation, and increases the risk of uterine disease in multiparous cows after calving.
Key words: predictability, stress, competition, animal welfare

INTRODUCTION

Despite decades of research, periparturient diseases remain a major animal welfare and economic challenge of the dairy industry. A goal of many dairy producers is disease prevention, but this approach requires knowledge of disease determinants, including the animals' immune competence, nutrition, and social environment (LeBlanc et al., 2006; Sepúlveda-Varas et al., 2013). Al-

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though numerous advancements have been made in the understanding of transition cow immunity and nutrition (LeBlanc et al., 2006), far less is known about the role of the social environment as a mediator of disease in transition cows.

Dairy cows may experience several social challenges during the transition period, including group changes, overstocked feeding and lying areas, and occasionally unpredictable management practices such as delayed feeding times or other disturbances to their daily routines. Some research has identified the effects of a single factor, such as overstocking, on cow behavior and health (Proudfoot et al., 2009; Huzzey et al., 2012). For example, in some of our earlier work we found that when cows were overstocked at the feeding areas (2 cows/bin), they increased their rate of feed intake (Proudfoot et al., 2009). However, less research has attempted to measure the combined effects of multiple sources of social disturbance on transition dairy cows.

The social environment may also affect physiological biomarkers of metabolism and inflammation in dairy cows. For example, Huzzey et al. (2012) have found that overstocking both the feeding and lying areas during the dry period increased blood nonesterified fatty acids (**NEFA**), an indicator of adipose mobilization and metabolic health that has been linked to disease after calving (Ospina et al., 2010a). Other research has found little effect of moderate increases in stocking density on cow health and behavior, such as increasing stocking density from 80 to 100% at the feed bunk (Silva et al., 2014). In humans, another mediator of stress-induced illness is chronic, systemic inflammation measured using pro-inflammatory cytokines [e.g., tumor necrosis factor (**TNF**)-α, IL-1b, and IL-6; reviewed by Popa et al., 2007]; however, to our knowledge no studies have measured the effect of the social environment on pro-inflammatory cytokines in dairy cattle.

It well known in the human and laboratory animal literature that unpredictable social environments may cause a physiological stress response, which in turn may lead to negative health outcomes if these stressors are additive, chronic, or severe in nature (Koolhaas et al., 2011). The research to date assessing the effect of social pressures on transition cows has focused on addressing a single factor, with little unpredictability in the cow's daily routine (e.g., Proudfoot et al., 2009; Huzzey et al., 2012; Silva et al., 2014). Thus, the objective of this study was to determine the effect of housing transition cows in an unpredictable and competitive social environment on feeding behavior, social behavior, indicators of metabolic health (NEFA, BHB, calcium, glucose), indicators of inflammation (TNF-α and haptoglobin), and uterine health (cytological endometritis) after calving. We predicted that cows in the unpredictable and competitive environment would change their feeding behavior and social behavior, and show increases in metabolic and inflammatory markers, and show a higher probability of endometritis after calving compared with those housed in a predictable and noncompetitive environment.

MATERIALS AND METHODS

The experiment took place at the University of British Columbia's Dairy Education and Research Centre in Agassiz, BC, Canada, between September 2012 and April 2013. Cows were cared for under protocol #A14–0040 approved by the University of British Columbia's Animal Care Committee according to the guidelines provided by the Canadian Council on Animal Care (2009).

Animals and Housing

Sixteen groups of 4 Holstein dairy cows were used in this experiment (n = 64). Each group included 1 primiparous cow and 3 multiparous cows (average parity 2.4 ± 1, mean ± SD; range 1 to 3) so the effects of parity could be assessed in the context of the treatment. All experimental cows were previously housed in 1 of 2 group freestall pens in the same building as the experimental pens. Cows were assigned to groups based on their expected calving dates to make the group assignments as random as possible. Groups were moved into 1 of 4 experimental pens approximately 5 wk before the average expected calving date of the cows in each group. To control for seasonal effects, groups from both treatments were moved into the pen at approximately the same time; when each group was finished with the experiment (i.e., when all of the cows had calved), a new group was added to the pen until all 16 groups completed the experiment.

Experimental pens (11.5 × 9.8 m) included 12 lying stalls fitted with mattresses (Pasture Mat, Promat Inc., Woodstock, Ontario, Canada) covered with 5 cm of sand bedding and vulcanized rubber floors in the alleys and crossovers (Red Barn Dairy Mat, North West Rubber Mats Ltd., Abbotsford, British Columbia, Canada). The pens also included 6 gated electronic feed bins (Insentec, Marknesse, Holland). To access the feed bins, cows were required to place their heads over a feed gate so that an antenna could read the unique radio frequency signal in their ear tag (Allflex, High-Performance ISO Half Duplex Electronic ID Tag, Allflex Canada, St-Hyacinthe, Quebec, Canada). Using a computer connected to the feeding system, experi-